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IRE Transactions on Antennas and Propagation
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H01Q

(54) **Spiral antennas**

(57) In a four arm spiral antenna 2 for direction finding, a pair of arms A, B of the four arm spiral are joined together so as to form a three terminal antenna which is arranged to be operatively associated with a pair of co-axial feeds so as to form a two port device.

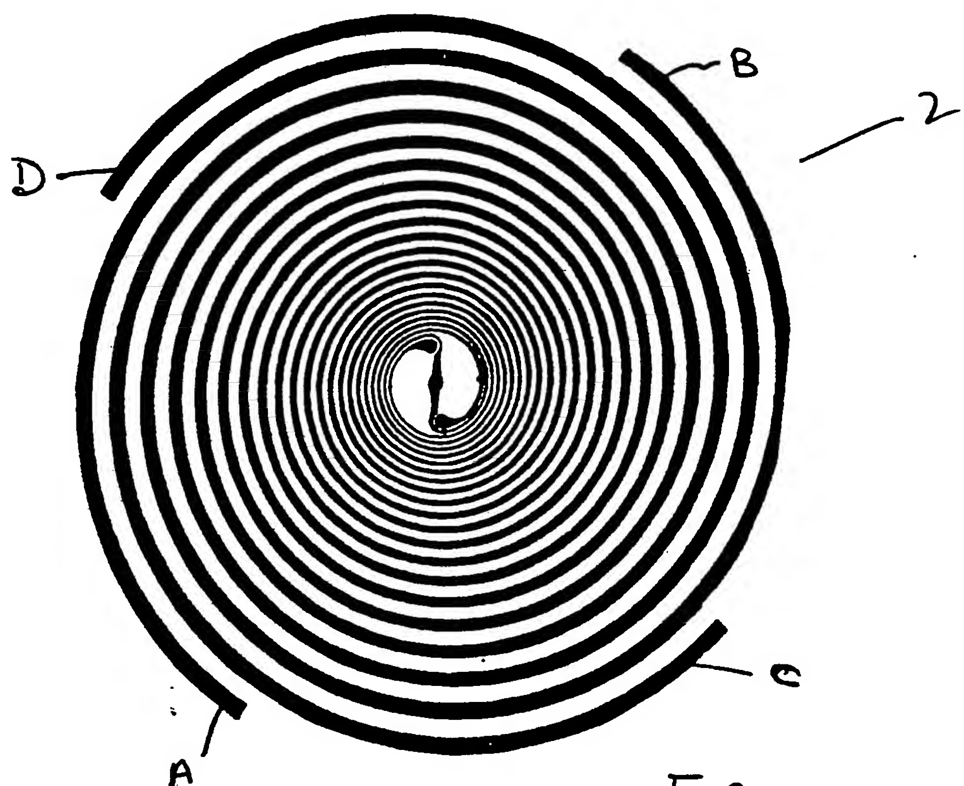

Fig 1.

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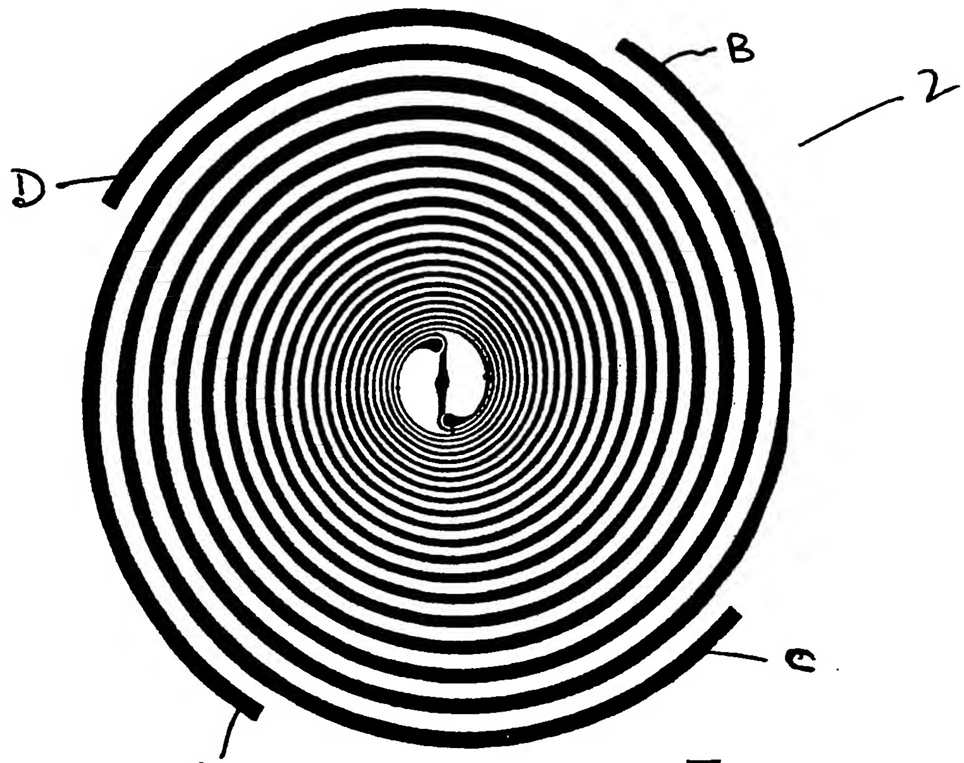

Fig 1.

Fig 2.

IMPROVEMENTS IN OR RELATING TO SPIRAL ANTENNAS

The present invention relates to spiral antennas, and more particularly to spiral antennas of dual mode operation.

The principles of dual mode operation of spiral antennas and more particularly of four arm spiral antennas for direction finding purposes are known and it is recognised that their associated mode extraction circuits tends to be relatively complex and have attendant sources of error which limit their performance.

Dual mode operation of multi-arm spirals and the impedance properties of multi-arm spirals have been discussed in a number of publications. There is a discussion of the subject in an article by Deschamps and Dyson entitled "The logarithmic spiral in a single-aperture multi-mode antenna system". I.E.E.E. Trans AP-19 Jan 1971 pp 90-95. There is also a discussion of the subject in a book entitled "Frequency independent antennas" by V. Rumsey. Academic Press 1966.

The complexity, cost, and bandwidth of the mode extraction networks is related both to the number of spiral arms and the number of antenna output ports and their interconnection, which in turn determines the impedance properties across the antenna output ports.

We have found that in general the impedances across the antenna ports are not guaranteed to provide efficient matching to a given mode extraction network for arbitrary interconnections between the antenna arms and the output ports and hence the performance of the antenna/mode extraction systems as a whole may exhibit restricted operational bandwidth.

An objective of the present invention is to exploit the broad band direction finding capability of a four arm spiral antenna type by using a specific interconnection technique between the antenna and its output ports so as to present convenient impedance levels to the mode extraction (direction finding) circuitry which completes the fundamental direction finding system. In addition, for this specific interconnection technique the mode extraction circuitry can be realised in a particularly simple form.

According to the present invention there is provided a four arm spiral antenna wherein a pair of arms of the four arm spiral are joined together so as to form a three terminal antenna for operative association with a pair of co-axial feeds.

In one embodiment said pair of arms are joined together at their ends in the central region of the spiral.

Advantageously said pair of arms are joined together at their ends in the central region of the spiral antenna, their ends being disposed substantially opposite to one another in that central region.

In a preferred arrangement the outer conductors of the two co-axial feeds are coupled to said pair of arms, and each inner conductor of the pair of co-axial feeds is coupled to a respective one of the other two arms of the four arm spiral thereby providing a two port antenna device for connecting to a mode extraction circuit.

Conveniently the three terminal antenna is coupled to the co-axial feeds by means of suitable baluns.

The present invention also provides a system for direction finding or beam forming comprising a four arm spiral antenna as defined above, the antenna being coupled by a pair of co-axial feeds to an external circuit. In one embodiment the co-axial feeds are coupled to a 180° hybrid such that both SUM and DIFFERENCE channels are provided for the direction finding information.

The present invention will be described further, by way of example, with reference to the accompanying drawing in which:-

Figure 1 illustrates a four arm spiral antenna according to an embodiment of the present invention; and

Figure 2 illustrates the central spiral feed

arrangement of the four arm spiral antenna of Figure 1.

Referring to the drawing a spiral antenna 2 comprises 4 spiral arms A, B, C and D. As can be more clearly seen from Figure 2 the centrally located opposite inner ends of the arms A and B are interconnected and joined to a connection feed point E, the opposite inner ends of the arms C and D each being connected to connection feed points F and G respectively. In this way a three terminal antenna is provided.

The outer earth conductors of two co-axial feeds in the form of co-axial cables (not shown) are coupled to the connection feed point E, each inner conductor of the pair of co-axial cables being coupled to a respective one of the connection feed points F and G. The coupling between the connection feed points E, F and G and the conductors of the coaxial cables is by means of suitable baluns (not shown).

When the two outputs from the spiral antenna are connected, either at RF or IF, to a 180° hybrid both SUM and DIFFERENCE channels which contain the direction finding information are obtained.

The particular interconnection described above between a four arm spiral and its two output ports provides impedance levels which are convenient to provide efficient matching between the

antenna output ports and the mode extraction circuitry and also provides a very simple means of extracting the relevant spiral modes. The particular method of joining the spiral arms at the feed also provides impedance levels which are convenient for port interconnection using distributed coupler balun transformer techniques or distributed quarter wave baluns based on 'Marchand' type designs or their derivatives.

The embodiments described above provide a broad band (multi-octave) wide field of view, two plane direction finding antenna. Other uses would include beam correction techniques (squint correction), beam steering and null steering/cancellation techniques.

In a system containing the antenna as described above the modes which are excited are capable of providing accurate direction finding or beam shaping properties.

In another embodiment a similarly interconnected antenna with a Null steering or Beam forming excitation network coupled to its two ports also provides a system for providing accurate direction finding or beam shaping properties.

Although the present invention has been described above with respect to particular embodiments, it should be understood that modifications may be effected within the scope of the invention. For example, whereas in the

embodiments described above the arms A, B, which are joined together at the connection feed point E, have their inner ends disposed opposite to one another; in other embodiments of the present invention the adjacent inner ends of the pairs of arms A and C, or A and D, or B and C, or B and D may be connected together to form the common connection feed point E.

CLAIMS:

1. A four arm spiral antenna wherein a pair of arms of the four arm spiral are joined together so as to form a three terminal antenna for operative association with a pair of co-axial feeds.

2. A four arm spiral antenna as claimed in claim 1 wherein said pair of arms are joined together at their ends in the central region of the four arm spiral.

3. A four arm spiral antenna as claimed in claim 2 wherein the ends of said pair of arms are disposed substantially opposite to one another in the central region.

4. A device including a four arm spiral antenna as claimed in any one of claims 1 to 3 wherein the outer conductors of two co-axial feeds are coupled to said pair of arms, and each inner conductor of the pair of co-axial feeds is coupled to a respective one of the other two arms of the four arm spiral thereby providing a two port device for connecting to a mode extraction circuit.

5. A device as claimed in claim 4 wherein the three terminal antenna is coupled to the co-axial feeds by means of baluns.

6. A system for direction finding including a device as claimed in claim 4 or claim 5 wherein the co-axial feeds are coupled to a 180° hybrid whereby both SUM and DIFFERENCE channels, which contain the direction finding information, are obtained.

7. A system for direction finding or beam forming, the system comprising a device as claimed in claim 4 or claim 5, the antenna being coupled by the pair of coaxial feeds to a mode extraction or beam forming circuit.

8. A four arm spiral antenna substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawing.

9. A system for direction finding or beam forming, the system including a four arm spiral antenna substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawing.

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